CLAIMS

What is claimed is:

1. A method for estimating the amplitude of an M-QAM signal based upon phase information from a plurality of transmitted symbols (d_k), the method comprising the steps of:

recovering a respective set of received symbols (r_k), corresponding to the plurality of transmitted symbols;

generating a set of products;

summing the set of products;

determining the real part of the sum of products;

summing the absolute values of the transmitted symbols $|(d_k)|$ to generate a magnitude value;

dividing the real part of the sum of products by the magnitude value to generate an estimated amplitude for the M-QAM signal.

2. The method of claim 1 wherein said generating step comprises:

multiplying each of the plurality of received symbols (r_k) by exp $[-j\theta(d_k)]$, wherein $\theta(d_k)$ represents the phase of a corresponding transmitting symbol (d_k).

3. A method for estimating the amplitude of a q-ASK signal at a receiver based upon magnitude information regarding a plurality of transmitted symbols (d_k), the method comprising the steps of:

recovering a respective set of N received samples (y_k) corresponding to the transmitted symbols (d_k);

for each of the N samples, multiplying the sample (y_k) by a corresponding sign (d_k) to generate a set of products (y_k)*sign(d_k);

summing the set of products to generate a first sum;

summing the absolute values of the transmitted symbols $|(d_k)|$ to generate a second sum;

dividing the first sum by the second sum to generate an estimated amplitude for the q-ASK signal.

4. A method for estimating the amplitude of a received signal which includes a set of N transmitted symbols (d_k), where N is a positive integer greater than one, the method comprising the steps of:

recovering a respective set of received samples (y_k) corresponding to the transmitted symbols (d_k);

determining the absolute values of the received samples $|(y_k)|$;

summing the absolute values to generate a first sum;

determining the mean of the absolute values of the amplitudes of transmitted symbols, $E|(d_k)|$;

multiplying the mean of the absolute values by N to generate a product, $N^* E|(d_k)|$;

dividing the first sum by the product to generate an estimated amplitude for the received signal.

5. The method of claim 4, wherein the received signal is an M-QAM signal.

6. The method of claim 4, wherein the received signal is a q-ASK signal.

7. A method for estimating the amplitude of an M-QAM signal that includes a set of transmitted symbols (d_k), the method comprising the steps of:

recovering a respective set of received samples (r_k) corresponding to the transmitted symbols (d_k);

determining the mean of the absolute values of the amplitudes of the transmitted symbols, $E|(d_k)|$;

determining the mean of the absolute values of the amplitudes of the received samples, $E|(r_k)|$; and

estimating amplitude $\grave{A}$ as: $\grave{A} = \{ [2*(E|r_k|^2)^2 - E|r_k|^4] / [2*(E|d_k|^2)^2 - E|d_k|^4]\}^{1/4}$.

8. A method for estimating the noise power of an M-QAM signal that includes a set of transmitted symbols (d_k), the method comprising the steps of:

recovering a respective set of received samples (r_k) corresponding to the transmitted symbols (d_k);

determining the mean of the absolute values of the amplitudes of the transmitted symbols, $E|(d_k)|$;

determining the mean of the absolute values of the amplitudes of the received samples, $E|(r_k)|$;

estimating amplitude $\grave{A}$ as: $\grave{A} = \{ [2*(E|r_k|^2)^2 - E|r_k|^4] / [2*(E|d_k|^2)^2 - E|d_k|^4]\}^{1/4;}$ and

estimating noise power $\sigma^2{}_n$ as: $\sigma^2{}_n = E|r_k|^2 - \grave{A}^2 E|d_k|^2$.

9. A method for estimating the signal-to-noise ratio (SNR) of an M-QAM signal that includes a set of transmitted symbols (d_k), the method comprising the steps of:

recovering a respective set of received samples (r_k) corresponding to the transmitted symbols (d_k);

determining the mean of the absolute values of the amplitudes of the transmitted symbols, $E|(d_k)|$;

determining the mean of the absolute values of the amplitudes of the received samples, $E|(r_k)|$;

estimating amplitude $\mathring{A}$ as: $\mathring{A} = \{ [2*(E|r_k|^2)^2 - E|r_k|^4] / [2*(E|d_k|^2)^2 - E|d_k|^4]\}^{1/4}$; and

estimating SNR as: $SNR = [\mathring{A}^2 * E|d_k|^2] / \sigma^2_n$.

10. A method for estimating the amplitude of a q-ASK signal that includes a set of transmitted symbols (d_k), the method including the steps of:

recovering a respective set of received samples (r_k) corresponding to the transmitted symbols (d_k);

determining the mean of the amplitudes of the transmitted symbols, $E(d_k)$;

determining the mean of the amplitudes of the received samples, $E(r_k)$; and

estimating amplitude $\mathring{A}$ as: $\mathring{A} = \{ [3*(E(r_k)^2)^2 - E(r_k)^4] / [3*(E(d_k)^2)^2 - E(d_k)^4]\}^{1/4}$.

11. A method for estimating the power of a q-ASK signal that includes a set of transmitted symbols (d_k), the method including the steps of:

recovering a respective set of received samples (r_k) corresponding to the transmitted symbols (d_k);

determining the mean of the amplitudes of the transmitted symbols, $E(d_k)$;

determining the mean of the amplitudes of the received samples, $E(r_k)$; and

estimating power as: $\mathring{A}^2 = \{ [3*(E(r_k)^2)^2 - E(r_k)^4] / [3*(E(d_k)^2)^2 - E(d_k)^4]\}^{1/2}$.

12. A method for estimating the noise power of a q-ASK signal that includes a set of transmitted symbols (d_k), the method including the steps of:

recovering a respective set of received samples (r_k) corresponding to the transmitted symbols (d_k);

determining the mean of the amplitudes of the transmitted symbols, $E(d_k)$;

determining the mean of the amplitudes of the received samples, $E(r_k)$;

estimating amplitude Å as: $Å = \{ [3*(E(r_k)^2)^2 - E(r_k)^4] / [3*(E(d_k)^2)^2 - E(d_k)^4]\}^{1/4}$; and

estimating noise power σ^2_n from the estimated amplitude Å as: $\sigma^2_n = E(r_k)^2 - Å^2 E(d_k)^2$.

13. A method for estimating the signal-to-noise ratio (SNR) of a q-ASK signal that includes a set of transmitted symbols (d_k), the method including the steps of:

recovering a respective set of received samples (r_k) corresponding to the transmitted symbols (d_k);

determining the mean of the amplitudes of the transmitted symbols, $E(d_k)$;

determining the mean of the amplitudes of the received samples, $E(r_k)$;

estimating amplitude Å as: $Å = \{ [3*(E(r_k)^2)^2 - E(r_k)^4] / [3*(E(d_k)^2)^2 - E(d_k)^4]\}^{1/4}$; and

estimating SNR as: $SNR = [Å^2 * E(d_k)^2] / \sigma^2_n$.

14. A method for estimating the signal-to-interference ratio of an M-QAM or q-ASK signal from second-order and fourth-order moments of received samples (r_k), wherein the second-order moment is defined as $E\{|r_k|^2\} = E\{|n_k|^2\} + E\{|d_k|^2\}$, and the fourth-

order moment is defined as $E\{|r_k|^4\} = E\{|n_k|^4\} + E\{|d_k|^4\} + 4E\{|n_k|^2\}E\{|d_k|^2\}$, where d_k denotes the transmitted symbols and n_k denotes a noise component that is recovered with the received samples r_k; the method comprising the steps of:

dividing the fourth-order moment by the second-order moment so as to implement a Kurtosis operation as:

$$Kurt(r) \equiv \frac{E\{|r_k|^4\}}{E\{|r_k|^2\}^2} = \frac{E\{|d_k|^4\} + E\{|n_k|^4\} + 4E\{|d_k|^2\}E\{|n_k|^2\}}{E\{|d_k|^2\}^2 + E\{|n_k|^2\}^2 + 2E\{|d_k|^2\}E\{|n_k|^2\}},$$

wherein the foregoing expression for Kurtosis includes a first Kurtosis component attributable to received signal, and a second Kurtosis component corresponding to received noise;

determining the first Kurtosis component able to the signal alone, (K_{sig}), as:

$$K_{sig} \equiv \frac{E\{|d_k|^4\}}{E\{|d_k|^2\}^2};$$

estimating the signal-to-noise ratio (SNR) as:

$$SNR = \frac{(2 - Kurt(r)) + \sqrt{(4 - 2K_{sig}) - (2 - K_{sig})Kurt(r)}}{(Kurt(r) - K_{sig})}.$$